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NORTH AMERICAN MONARCH BUTTERFLY CONSERVATION PLAN (NAMCP)

Prepared by the Secretariat of the Commission for Environmental Cooperation

March 2008

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North American Monarch Butterfly Conservation Plan

Executive Summary[TC "Executive Summary" \f C \l "1"]

The monarch butterfly (*Danaus plexippus*) may be the most well-known butterfly in the world. The migrations of monarch butterflies in North America to overwintering sites in Mexico and California are among the most spectacular and unusual of the world's natural events. However, habitat loss and degradation pose threats to both the eastern and western migratory populations of North American monarchs throughout their annual cycle of breeding, migrating and overwintering. The decline of the migratory phenomenon is certain unless these threats are addressed.

Monarchs depend upon a wide range of habitats in Canada, the United States and Mexico and conservation of the migratory phenomenon requires trilateral cooperation. The North American Monarch Conservation Plan (NAMCP) is intended to provide a long-term cooperative agenda for conservation of the monarch butterfly.

~~The process to develop a North American Monarch Butterfly Conservation Plan began in May 2007 when the Mexican portion of the Biodiversity Conservation Working Group (BCWG) presented a proposal to its counterparts at their annual meeting in Quebec City. The trinational BCWG further elaborated on it and agreed to bring it forward to the CEC Council. In June 2007 CEC's Council provided instruction to the Secretariat to foster trinational cooperation to conserve the Monarch butterfly and promote sustainable local livelihoods through resolution 07-09.~~

~~The North American Monarch Butterfly Conservation Plan was a result of a trinational workshop hosted by the CEC in Morelia, Michoacan in December 2007 and benefited from the valuable contributions and in-depth review of an extensive list of experts from diverse backgrounds from Canada, Mexico and the United States. Furthermore, the content of this NAMCP has been sharedwith diverse government agencies found within each country related to the well-being of the species (see list of acknowledgements below).~~

~~During the development of this plan, particular attention was given to build upon current activities of the multi-stakeholder collaborative effort initiated at the Monarch Flyway Conservation Workshop in Mission, Texas, developed further at the Regional Monarch Butterfly Forum in Morelia, Mexico by the North American Monarch Conservation Committee (NAMCC), and endorsed by the Trilateral Committee meeting in May 2007 in Quebec City.~~

The NAMCP is divided into eleven sections. The initial seven ~~four~~ sections provide an updated account of the species and its current situation. The eighth ~~fifth~~ section identifies the main causes of loss or decline and puts in perspective the ensuing sections related to current management actions taken in each country, as well as public perception of the species. Against this background, the last section offers a list of key trinational collaborative conservation actions.

~~The migrations of monarch butterflies in North America to overwintering sites in Mexico and California are among the most spectacular and unusual of the world's natural events. However, habitat loss and degradation pose threats to both the eastern and western migratory populations of North American monarchs throughout their annual cycle of breeding, migrating and~~

~~overwintering; their decline of the migratory phenomenon is certain unless these threats are addressed. The relatively small size of the wintering sites make the loss of these habitats, from commercial and subsistence scale timber harvesting in Mexico and commercial and municipal development in California, of the most immediate concern.~~

This document summarizes evidence of the rate of habitat loss during each stage of the monarch's annual cycle. The relatively small size of the wintering sites make the loss of these habitats, from commercial and subsistence scale timber harvesting in Mexico and commercial and municipal development in California, of the most immediate concern. Recent analyses of the overwintering area document an accumulated loss of a fifth of the forested land in the Monarch Butterfly Biosphere Reserve (MBBR) in Mexico from 1986 to 2006. Changing farm practices and suburbanization of agricultural land in the United States are resulting in losses of approximately 876,000 hectares/year of land that can support the host plants and nectar sources required for monarch reproduction and migration.

Habitat conservation and restoration are absolutely necessary for monarch survival. Mexico, Canada and the United States must work together to ensure that 1) sufficient suitable habitat is available on the overwintering grounds in ~~the United States~~ California and Mexico for the populations to persist; and 2) sufficient breeding and migrating habitat is available in Canada, Mexico and the United States to maintain their current contribution to the overall North American population.

Objectives of the most immediate importance, and with the most potential for trilateral cooperation, are to:

1. **Decrease or eliminate** ~~net forest loss~~ deforestation **due to unsustainable logging and habitat conversion in the overwintering habitat.** This objective must be accomplished through a combination of surveillance and enforcement of existing laws, prevention and mitigation actions, and support for alternative and sustainable forest management and economic practices.
2. **Address threats of habitat loss and degradation in the flyway.** Effective flyway conservation requires immediate management actions. These actions must be supported by research and monitoring to identify the habitat types and locations that are most important to monarchs during their spring and autumn migrations, and an understanding of how human activities affect the availability and suitability of these habitats.
3. **Address threats of loss, fragmentation, and modification of breeding habitat.** Breeding habitat conservation will require better understanding of monarch host plants, including how land use practices affect the distribution and abundance of numerous milkweed (*Asclepias*) species. Land use practices that support monarch breeding should be encouraged among government agencies, private conservation organizations, and public and private landowners.
4. **Develop innovative enabling** ~~practices~~approaches**.** Incentives for conservation, such as the payment for environmental services by the ~~Fondo Mexicano~~ Monarch Butterfly Conservation Fund (FMCN) in the MBBR, could help to mitigate threats due to habitat loss. Cooperative trilateral actions, such as supporting ~~existing~~ and expanding the network of ~~and creating new~~ Sister Protected Areas involved in monarch conservation will protect ~~monarch~~ habitat, support environmental education, and reinforce monitoring

efforts. Such efforts should be expanded and duplicated in other areas and by other organizations.

5. **Monitor monarch baseline performance and habitat quality, including water availability.** Government and non-government agencies should support the development and dissemination of a monitoring program, and a diagnosis of biological and socioeconomic drivers of monarch population dynamics. Coordinated monitoring throughout the monarch's annual cycle and open sharing of the data are key to understanding the status of the population and effectiveness of conservation actions.

Acknowledgements[TC "Acknowledgements" \f C \l "1"]

The CEC is grateful for the many valuable contributions of knowledge and experience generously received from experts throughout the NAMCP development process. This includes the participants attending the Morelia workshop, 5-7 December 2007, where the NAMCP framework was developed, and the experts from the diverse government agencies, NGOs and academia who reviewed the resulting draft for the North American Monarch Butterfly Conservation Plan.

We are especially grateful to the following individuals for their contributions to these development stages:
Karen Oberhauser, from the University of Minnesota and Monarch Butterfly Sanctuary, for her role as coordinator and principal editor of the NAMCP.

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Sandra Baumgartner, Tara Crewe, Donald Davis, Jean Lauriault, Flavio Cházaro Ramírez, Alfredo Cruz Colín, María Guadalupe del Río de Garciadiego, Carlos Enrique Galindo Leal, Eligio García Serrano, Francisco Lana Contreras, Felipe Martínez Mesa, Concepción Miguel Martínez, Irene Pisanty Baruch, Héctor Quintanilla Heredia, Oscar Manuel Ramírez Flores, María Isabel Ramírez Ramírez, Eduardo Rendón Salinas, Juan José Reyes Rodríguez, Juan Francisco Torres Origel, María del Rocío Treviño Ulloa, Donita Cotter, Andrew K. Davis, Dennis Frey, Elizabeth Howard, Stephen Malcom, Eneida Beatriz Montesinos Patiño, Douglas Taron, Brian Houseal for his role as facilitator during the workshop, Hans Herrmann and Karen Schmidt.

Reviewers of subsequent drafts:
Lincoln P. Brower, Exequiel Ezcurra Real de Azua, Scott Hoffman Black, Jürgen Hoth, Fiona Hunter, Felix Sperling, Orley Taylor Jr., Irene Pisanty Baruch.

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North American Monarch Conservation Committee members include:
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2.Environment Canada / Canadian Wildlife Service
3.Ontario Nature/Federation of Ontario Naturalists: Don Davis
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4.Monarch Butterfly Biosphere Reserve: Concepción Miguel Martínez, Felipe
5.Michoacán Forestry Commissioner: Juan José Reyes Rodríguez
6.World Wildlife Fund- Mexico: Carlos Galindo Leal
UNITED STATES
7.US Fish and Wildlife Service: Donita Cotter
8.Texas Parks and Wildlife Department: Maria Araujo
9. | University of Minnesota and Monarch Butterfly Sanctuary Foundation: Karen Oberhauser (chair)

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Acknowledgments

There is a long history of research and cooperation between government agencies, non-government organizations, the public, and the scientific community to promote monarch conservation. An endeavor such as the North American Monarch Conservation Plan would not be possible without their dedicated efforts.

We owe an enormous debt of gratitude to the participants and experts who provided their wisdom and knowledge through participation in the various meetings and workshops (listed below) that led to the development of the NAMCP. We thank the agencies and organizations who co-hosted workshops and meetings.

We are especially grateful to Karen Oberhauser, from the University of Minnesota and Monarch Butterfly Sanctuary for her role as coordinator and principal editor of the NAMCP.

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CEC's Trinational Experts Workshop: Developing a North American Monarch Butterfly Conservation Plan, Morelia, Michoacan, December 5-7, 2007

The Trinational Experts Workshop was organized by the Secretariat at the direction of the CEC Council through Resolution 07-09, *Trinational cooperation to conserve the monarch butterfly and promote sustainable local livelihoods*, to build upon the multi-stakeholder, collaborative NAMCP initiative launched at the 2006 Monarch Flyway Conservation Workshop.

Participants: Sandra Baumgartner, Flavio Chazaro Ramirez, Donita Cotter, Tara Crewe, Alfredo Cruz Colin, Andrew Davis, Donald Davis, Maria Guadalupe Del Rio de Garciadiego, Dennis Frey, Carlos Enrique Galindo Leal, Eligio Garcia Serrano, Elizabeth Howard, Jean Lauriault, Francisco Luna Contreras, Stephen Malcolm, Felipe Martinez Meza, Concepcion Miguel Martinez, Eneida Beatriz Montesinos Patino, Irene Pisanty Baruch, Hector Quintanilla Heredia, Oscar Manuel Ramirez Flores, Maria Isabel Ramirez Ramirez, Eduardo Rendon Salinas, Juan Jose Reyes Rodrizuez, Douglas Taron, Juan Francisco Torres Origel, Maria del Rocio Trevino Ulloa, Brian Housel (facilitador), Hans Hermann, Karen Schmidt

We also thank the CEC's Biodiversity Conservation Working Group (BCWG) for their support and endorsement for the NAMCP initiative.

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Monarch Flyway Conservation Workshop, Mission, Texas, December 6-7, 2006

The initiative to prepare a NAMCP was launched at the December 2006 Monarch Flyway Conservation Workshop in Mission, Texas. The workshop was sponsored by the US Forest Service (USFS) – International Programs, US Aid for International Development (USAID, Texas Parks and Wildlife Department (TPWD), the Wildlife Trust, and City of McAllen, Texas. The workshop was attended by representatives of agencies, academia, and NGOs from the three countries.

Participants: Maria Araujo, Lincoln Brower, Oscar Contreras Contreras, Donita Cotter, Carol Cullar, Don Davis, Guadalupe Del Rio Pesado, Janet Ekstrum, Mike Engel, Dan Evans, Jesus Franco, Rebecca Goodwin, Mary Gustafson, Margee Haines, Richard Holthausen, Colleen Hook, Buddy Hudson, Mary Kennedy, Jean Laurialt, Carol Lively, Rolando Madrid, Helen Molina Sanchez, Sandra Nitchie, Karen Oberhauser, Mike Quinn, Jeff Raasch, Mike Rizo, Craig Rudolph, Phil Schappert, Evan Seed, Karen Shannon, Sue Sill, Chip Taylor, Carmen Telez-O'Mahony, Matt Wagner, Don Wilhelm, Juan Manuel Fausto Leyva, Jose Andres Garcia Almanza, Eligio Garcia Serrano, Tomas Martinez Ramirez, Lidia Miranda Sanchez, Eduardo Rendon Salinas, Juan Jose Reyes Rodriguez, Alfonso Rojas Pizano, Alejandro Torres, Xicotencatl Vega, Adriana Vlera-Bermejo, Tiburico Ybarra Caballero

Workshop participants selected three representatives from each country to serve on a planning committee. The NAMCP Committee met twice to develop plan objectives and action items.

- ***NAMCP Committee at 4th Monarch Butterfly Regional Forum (Foro Monarca), Morelia, Michoacan, March 14-16, 2007*** - Maria Araujo, Jean Laurialt, Carlos Galindo Leal, Concepiion Miguel Martinez, Karen Oberhauser, Juan Jose Reyes Rodriguez
- ***NAMCP Committee at XII Meeting of the Canada/Mexico/US Trilateral Committee for Wildlife & Ecosystem Conservation and Management, Quebec City, Quebec, May 13, 2007*** - Maria Araujo, Donita Cotter, Donald Davis, Pia Gallina, Margee Haines, Karen Oberhauser, Irene Pisanty, Eduardo Rendon, Juan Jose Reyes Rodriguez, Mary Rothfels

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Trilateral Monarch Butterfly Sister Protected Area Workshop, Morelia, Michoacan, March 27-30, 2006

The initiative to establish a network of Sister Protected Areas to collaborate on monarch conservation projects and seek CEC funding for a handbook of standardized monitoring protocols was launched at this workshop hosted by Mexico's National Commission of Natural Protected Areas (CONANP), the US Fish and Wildlife Service-National Wildlife Refuge System, and the Canadian Wildlife Service (CWS).

Background[TC "Background" \f C \l "1"]

The monarch butterfly (*Danaus plexippus* (L.)) may be the most well-known butterfly in the world. It has been the focus of research on insect and host plant interactions, insect defenses, mimicry, migration, reproductive physiology, overwintering biology, habitat conservation, community management, ecotourism, and many other topics. This butterfly is best known for the incredible migration made by the eastern North American population, in which individuals fly from their summer breeding grounds as far north as southern Canada to overwintering habitat in central Mexico. ~~While~~ Although the species itself is not in danger of extinction, the North American migration is considered an endangered biological phenomenon due to threats to monarch habitat during its annual cycle of breeding, migrating and wintering~~, prompted the International Union for Conservation of Nature to declare the monarch migration an endangered phenomenon in 1983~~. Because monarchs depend upon a wide range of habitats in Canada, the United States and Mexico, conservation of thise migratory phenomenon requires trilateral cooperation.

Commented [dcc1]: The IUCN designation is described and cited in the Legal Status ... International section

Description of species[TC "Description of species" \f C \l "1"]

Monarch butterflies are in the family Nymphalidae, sub-family Danainae. The monarch was named *Papilio plexippus* by Linnaeus in 1758 (Vane-Wright 2007). It is the type species of the genus *Danaus*, which was named by Kluk in 1780. While a recent catalogue of Latin American butterflies recognized six subspecies of *D. plexippus* (Lamas 2004), mitochondrial DNA sequences suggest that these groups are not genetically distinct (Brower and Jeansonne 2004) and at least one of the subspecies (*D. plexippus megalippe*) may mix in the Caribbean with migratory *D. plexippus plexippus*. Here we are concerned with the subspecies *Danaus plexippus plexippus* in Mexico, the United States and Canada.

Adults[TC "Adults" \f C \l "2"]

The adult monarch is a relatively large butterfly, with a wingspan of approximately 9 to 11 cm. Its bright orange wings have black veins, and black edges that contain white spots along the margin. The underside of the wings is duller orange so that when the wings are folded in rest, the butterflies appear camouflaged as they cluster or rest singly in trees or on other substrates. The species is sexually dimorphic; males are slightly larger than females and have a black spot on each hindwing consisting of androconial scales. Pheromone-producing androconial scales are used, in related species, to attract mates. However, most researchers agree that chemical communication plays a less significant role in monarch butterflies, compared with other species in the same genus. Females lack the androconial patch, have slightly more brown scales in the orange patches of their wings, and have more black scales over the wing veins, making the veins appear wider.

Figure 1. Insert pictures of males and females here

There are color variants in adult monarchs, most notably a variation or morph (*nivosus*) in which the orange is replaced with white (Stimson and Meyers 1984). This color variation is caused by a single recessive gene, and has been found throughout the world, including Australia, New Zealand, Indonesia and the United States. It is extremely rare everywhere but Hawaii, where it

sometimes comprises up to 10% of the population (Stimson and Berman 1990, Vane-Wright 1986).

Monarch adults are sometimes confused with related butterfly species, including *D. gilippus* (the queen butterfly), *D. eresimus* (the soldier butterfly) and *D. erippus* (the South American monarch), and *Limenitis archippus* (the North American viceroy butterfly).

Figure 2. Insert picture of viceroy

Migratory North American monarchs undergo several generations per year. The summer generation adults live between two and five weeks. The late generation adults migrate, then overwinter ~~in a state of reproductive diapause (Herman 1981)~~ at sites in Mexico and California. These overwintering individuals live seven to nine months, without breeding and laying eggs until the following spring as they remigrate toward their spring and summer breeding ranges.

Eggs[TC "Eggs" \f C \l "2"]

Monarch eggs are conical with a flat base. They are approximately 1.2 mm tall by 0.9 mm in diameter at the widest point, and are a pale, yellow-cream color with ridges running from the tip to the base. Monarchs only lay their eggs on milkweed plants. Adult females lay eggs singly, secreting a glue-like substance that adheres the egg to a milkweed plant. Wild females probably lay from 300 to 400 eggs over the course of their lifetime, although captive females can lay, on average, ~~approximately~~ 700 eggs in two to five weeks (Oberhauser 2004). The larvae emerge in three to five days, with shorter development times corresponding to warmer temperatures.

Figure 3. Insert picture of egg here

Larvae[TC "Larvae" \f C \l "2"]

Monarch larvae (caterpillars) are white with black and yellow stripes and have two pairs of black filaments, on larval segments 2 and 11. Larvae undergo five instars over a period of nine to 13 days. While the bright color patterns on monarch larvae probably represent aposematic, or warning, coloration, monarchs in the egg and larval stages suffer high rates of predation from invertebrate predators. Several studies have documented mortality rates of over 90% during these stages (reviewed in Zalucki et al. 2002, Prysby 2004). It appears that the chemical defense gained from ingesting toxic milkweed cardenolides (see ~~below~~ Host Plants: Milkweed section ~~below~~) is more effective against vertebrate predators, although Rayor (2004) documented a preference by wasp predators for larvae that had fed on milkweed species having lower cardenolide levels.

Once fifth instar larvae are fully grown they leave their milkweed host plant to search for an elevated and usually well-hidden pupation site.

Figure 4. Insert picture of larvae here

Pupae[TC "Pupae" \f C \l "2"]

Monarch pupae (chrysalids) are about 3 cm long and are bright turquoise green with gold spots. These metallic-appearing spots are typical of the Danainae, and are caused by alternating layers in the endocuticle that are dense and clear. These layers reflect and transmit light differently, and cause constructive interference of light, making them look like shiny metals.

The pupa stage lasts nine to 15 days under normal summer conditions. This is the least studied stage of monarchs, due to the difficulty in finding pupae in the wild. This difficulty suggests that monarch pupae are cryptically colored, ~~despite the cardenolide processing that must occur to result in chemically-defended adults~~as opposed to the aposematic coloration exhibited by adults. On the last day as a pupa, the orange, black, and white patterns of the adult wings become visible through the pupal covering.

Figure 5. Insert picture of pupa here

Host Plants: Milkweed[TC "Host Plants: Milkweed" \f C \l "1"]

Monarch larvae are ~~specialist~~ obligate herbivores of milkweeds and are likely to feed on any of the approximately 115 species in the genus *Asclepias* in North America and the Caribbean (Malcolm et al. 1992, Malcolm 1994). This genus of perennial plants, with over 140 species world-wide, was also named by Linnaeus. He named milkweeds after Asklepios, the Greek god of healing, because of their many folk-medicinal uses. ~~They~~Monarchs also feed on milkweed vines in the genera *Sarcostemma, Cynanchum* and *Matelea* (Ackery and Vane-Wright 1984~~),~~). Until recently, these genera were included in the family Asclepiadaceae, but the family is now treated as a subfamily in the dogbane family, Apocynaceae. In addition to being the larval food source for monarchs, their close relatives, and several other specialist insects, milkweeds are important nectar sources for many insects.

Commented [dcc2]: This reference is why I moved the section forward on Linnaeus also naming the monarch butterfly

Milkweed is named for its milky sap, which contains alkaloids and other complex compounds including cardenolides. In Spanish, milkweed is known as *venenillo* (small poison) and *algodoncillo* (small cotton) due to the toxic nature of the plant and the appearance of the seeds. The milky sap, or latex, confers both mechanical and chemical defenses against potential herbivores (Malcolm et al. 1992, Malcolm 1994), but monarch larvae show a range of feeding behaviors that circumvent these latex defenses (Dussourd and Eisner 1987, Dussourd 1993, Zalucki and Brower 1992, Zalucki and Malcolm 1999).

Cardenolides are a type of steroid-glycoside that include digitoxin; they induce nausea, vomiting, diarrhea, and cardiac arrhythmias in vertebrates. As larvae feed on milkweed, they sequester cardenolides for use as a chemical defense against natural enemies (Brower 1984). Cardenolide levels vary both within and between milkweed species and are inducible by damage or herbivore feeding (Malcolm and Zalucki 1996). While monarch feeding on many milkweed species has been documented, our knowledge of how monarch survival is affected by the female's choice of host plants is incomplete.

Milkweed grows in a variety of disturbed and undisturbed environments, including farmlands, along roadsides and in ditches, open wetlands, dry sandy areas, short and tall grass prairie, agricultural areas, river banks, irrigation ditches, and arid valleys. Many species, especially *A. incarnata* (swamp milkweed), *A. curassavica,* (tropical milkweed, or bloodflower) and *A. tuberosa* (butterfly weed) are often planted in gardens.

Livestock pastures can also represent significant milkweed habitat for monarchs. Some milkweeds are toxic to livestock (Malcolm 1991), especially if they are included in harvested livestock feed. However, the bitter taste of cardenolides in milkweeds may deter livestock sufficiently that milkweeds are not a serious problem when growing wild in pastures. Thus it is common to see extensive milkweed growth in pastures throughout North America, and these plants may be an important food resource for monarchs.

Woodson (1954) provides a good background on the distribution of milkweed species in the United States and Canada, but less is known about their distribution in Mexico. The most widely-used monarch host plant in the northern United States and Canada is the common milkweed, *A. syriaca* (Malcolm et al. 1989), which thrives in disturbed areas and has probably been particularly successful following the development of agriculture in the grasslands and former forests in the central and northeastern United States and southeastern Canada (Malcolm et al. 1989, Vane-Wright 1993, Brower 1995). Because it thrives in disturbed habitats, natural plant succession affects common milkweed distribution and abundance. *A. viridis, A. asperula* and *A. oenotheroides* are important host plants in the southern United States. *A. currassavica* is probably the most important host species in Mexico, but Montesinos (2003) also reports finding eggs and larvae on *A. glausences* in the state of Michoacan.

~~This genus of perennial plants, with over 140 species world-wide, was also named by Linnaeus. He named milkweeds after Asklepios, the Greek god of healing, because of their many folk-medicinal uses. Until recently, the genus was included in the family Asclepiadaceae, but the family is now treated as a subfamily in the dogbane family, Apocynaceae. In addition to being the larval food source for monarchs, their close relatives, and several other specialist insects, milkweeds are important nectar sources for many insects.~~

Commented [dcc3]: This reference is why I moved the section forward on Linnaeus also naming the monarch butterfly

Milkweed pollination is accomplished in an unusual manner. The pollen is contained in structures called pollinia (pollen sacs), rather than occurring as free grains as is the case for pollen in the rest of the Apocynaceae. Pollinia attach to hairs or bristles on the feet or heads of visiting insects, and are carried to the receptive surfaces of other milkweeds. The most effective milkweed pollinators are large wasps, although bees, moths and butterflies can also carry the pollen from plant to plant. Of those milkweeds that have been studied, the majority are self-incompatible, which means that they must receive pollen from other milkweeds of the same species to produce viable seeds.

Figure 6. Insert pictures of various milkweed most used by monarchs and flowers here

A. syriaca and its close relative, *A. speciosa*, have a peculiar root system that ramifies underground, and can cover thousands of meters. It is possible that a single plant (known as a genet) can form hundreds, and possibly even thousands of stems (known as ramets) that are genetically identical.

Figure 7. Insert photo of milkweed roots from steve malcolm

The Monarch Butterfly's Annual Life Cycle[TC "The Monarch Butterfly's Annual Life Cycle" \f C \l "1"]

North American monarchs form two fairly distinct populations. The Western migratory population breeds in the western United States and Canada, and winters near the California coast. ~~and t~~The Eastern migratory population breeds in the central and eastern ~~eastern~~ United States and in southern Canada, and winters in central Mexico (in the eastern part of the state of Michoacán and western part of the state of ~~Estado de~~ México). The monarchs that spend the winter in the mountains of central Mexico or eucalyptus groves of coastal California are the final generation of a cycle that begins anew each year. Most of the butterflies in this final generation begin their lives as larvae in the northern United States or southern Canada, and then migrate up to thousands of kilometers to specific overwintering sites. After spending several months at these sites, they fly north and east, starting the cycle again.

Butterflies that are part of the Eastern population lay eggs in northern Mexico and the southern United States. These eggs become the adults that recolonize the northern part of the breeding range (Malcolm et al. 1987, 1993), and the population undergoes two more breeding generations. Only the final generation of the year remigrates to Mexico in the fall. The behavior of the Wwestern population is similar, although the generation that overwinters probably recolonizes most of the summer range, with subsequent generations increasing in numbers over the summer. Spring and summer adults live about a month, and those that migrate and overwinter in Mexico live up to seven to nine months.

Figure 8. Insert migration maps here

Migration[TC "Migration" \f C \l "2"]

Although they live in temperate regions during the summer, monarch butterflies, like other Danainae, are essentially a tropical species. Unlike other temperate insects, no life stage of the monarch butterfly can survive temperate winters. Every autumn, North American monarchs undergo a southward migration to winter roosting sites, and recolonize their breeding range the following spring. The monarch is the only butterfly to make such a long, two-way migration, with most of those in the east flying over 2500 km to reach their winter destination. Migratory individuals are typically in reproductive diapause, a state of suspended reproductive development that is controlled by neural and hormonal changes (Herman 1981) triggered by environmental changes including decreasing day length, increasingly cooler nights, and perhaps host plant senescence (Goehring and Oberhauser 2002). Since the discovery of these wintering ~~colonies~~ sites in Mexico by the scientific community in 1975 (Urquhart 1976), researchers have struggled to understand the cues that cause monarchs to begin their migration, the mechanisms they use to orient and find the overwintering sites and the patterns of fall and spring flights (Solensky 2004, Zhu et al. 2008).

~~Nectar sources are vital to monarchs during their fall migration, when they need carbohydrates to fuel their flight and convert to the fat that supports them during the winter (Brower 1985, Masters et al. 1988, Gibo and McCurdy 1993, Brower et al. 2006). A variety of flowering plants are used during the fall migration; of particular note are goldenrods (*Solidago spp.*), asters (*Aster spp.*), and gayfeathers (*Liatris spp.*) in the north, and frostweed (*Verbesina virginica*) in Texas. Blooming clover, sunflower and alfalfa fields can also host thousands of monarchs (K. Oberhauser, E. Howard, pers. obs.).~~

Commented [dcc4]: I moved this paragraph to follow the next paragraph

Monarch migration appears to be a fairly flexible behavior that changes in response to new environments. For example, Australian monarchs sometimes exhibit seasonal movement, moving from inland to coastal areas in a north to northeasterly direction during the fall and winter (James 1993). Hawaiian, Caribbean, Mexican and South American populations do not migrate. Because the most spectacular monarch migrations occur in the eastern North American population, much of the research on monarch migration has focused on this population. These butterflies fly from their summer breeding range, which spans more than 100 million ha, to winter roosts that cover less than 20 ha, often to the same forest sites, year after year.

Nectar sources are vital to monarchs during their fall migration, when they need carbohydrates to fuel their flight and convert to the lipid reserves or fat that supports them during the winter (Brower 1985, Masters et al. 1988, Gibo and McCurdy 1993, Brower et al. 2006). A variety of flowering plants are used during the fall migration; of particular note are goldenrods (*Solidago spp.*), asters (*Aster spp.*), and gayfeathers (*Liatris spp.*) in the north, and frostweed (*Verbesina virginica*) in Texas. Blooming clover, sunflower and alfalfa fields can also host thousands of monarchs (K. Oberhauser, E. Howard, pers. obs.).

While it has often been assumed that the eastern and western North American populations are strictly separated by the Rocky Mountains, recent evidence suggests that some western monarchs move south and southeast, entering the Mexican state of Sonora from Arizona (Pyle 2000, Brower and Pyle 2004). It is possible that some degree of genetic interchange occurs in Mexico and within the Rocky Mountains during the breeding season, preventing complete separation of the two populations.

Overwintering[TC "Overwintering" \f C \l "2"]

Mexico: ~~Overwintering monarchs form dense clusters on the branches and trunks of trees.~~ The eastern monarchs spend the winter in a temperate mountain ecosystem in Mexico dominated by oyamel firs (*Abies religiosa*) (Brower 1995). Overwintering monarchs form dense clusters on the branches and trunks of trees and large aggregations of butterflies in a discrete area are called a colony. Their colonies range in size from 0.5 to 5 ha, and occur on 12 different massifs in the ~~transverse neovolcanic belt of~~ Transverse Neovolcanic Belt, a belt of volcanic mountain ranges and valleys ~~ranges~~ extending across central Mexico (approximately 19° N and 100° W) (Calvert and Brower 1986, Slayback et al. 2007). The majority of the colonies are within the federally protected Monarch Butterfly Biosphere Reserve (MBBR) administered by the National Commission of Natural Protected Areas (CONANP).

The high altitude forests provide a cool microhabitat which results in a low metabolic rate and reduced activity from mid-November to mid-March (Brower 1996). Overwintering colonies are spread over an area approximately 100 km x 100 km (Calvert and Brower 1986), but recent analyses show that the appropriate microclimatic conditions occur in approximately 562 km^2 of the entire 10,000 km^2 region (Slayback et al. 2007). Within the suitable area, individuals sometimes settle on the same stands of trees as their predecessors did in the previous winter, and in other years, they may settle up to 1.5 km away (Slayback et al. 2007).

Although no formal scientific studies have been published on the importance of access to water by overwintering monarchs, there are many indications that access to moisture is of key importance. Monarchs form colonies at the heads of the streams, and as the dry season advances

and the stream sources drop down the arroyos (valleys), the monarch colonies move down, presumably to avoid desiccation (Calvert and Brower 1986). Additionally, massive flights out of the colonies to drink at natural water sources occur regularly and with increasing frequency as the dry season advances. Literally millions of monarchs fly out of their colonies and alight along moist stream banks and water seeps where they drink. The butterflies also drink moisture that condenses as frost on the open llanos (meadow) vegetation. The guides at the tourist facility at El Rosario colonytourist facility have taken advantage of this fact, piping water from springs and spraying it over vegetation which is then visited by thousands of monarchs, to the delight of visiting tourists. Lincoln Brower (personal communication) notes that southwestern winds that blow across the volcanic plain often result in adiabatic condensation of clouds as the winds are forced up over the Chincua mountain range. Oyamel fir needles are often covered with moisture, and during adiabatic events, in a phenomenon known as "fog drip", water drops fall from the trees onto the ground. ~~The phenomenon of "fog drip" is well known in the California redwood forests where it accounts for a significant proportion of the entire ground water recharge.~~

Figure 9. Insert pictures from overwintering sites here including CA

California: Prior to European settlement, overwintering monarchs presumably used native forests along the California coast. Deforestation taking place in coastal California in the 19th century led to a decline in overwintering habitat for monarchs. Subsequently, pine forests were largely replaced by *Eucalyptus* trees, introduced in the 1850's for landscaping, as windbreaks, and for use as fuel (Lane 1993). Now, coastal California monarch wintering sites consist of wooded areas most often dominated by the non-native eucalyptus (*Eucalyptus spp.*), although monarchs also use the native Monterey pines (*Pinus radiata*), Monterey cypresses (*Cupressus macrocarpa*) and redwoods (*Sequoia sempervirens*) when these species are present. The sites are typically located in sheltered bays or farther inland, where they provide moderated microclimates and protection from strong winds. More than 300 different aggregation sites have been reported (Frey and Schaffner 2004, Leong et al. 2004), with high degrees of year-to-year fidelity to specific locations. As is true of the monarchs overwintering in Mexico, access to water, particularly early morning dew, appears to be important to winter survival. The phenomenon of "fog drip" is well known in the California redwood forests where it accounts for a significant proportion of the entire ground water recharge.

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Winter Breeding Populations: Small, non-migrating populations persist for most years in southern Florida (Knight et al. 1999, Altizer et al. 2000). It is likely that they are periodically extirpated due to low temperatures, and receive an influx of migratory individuals from the eastern migratory population each fall (Knight et al. 1999). These individuals, as well as the monarchs of Cuba (Dockx 2007), probably do not represent a separate population. Resident populations have also been reported in Texas and other Gulf Coast states, and may be becoming more common (K. Oberhauser and R. Batalden pers. obs.). These populations are probably temporary, and may represent individuals from the migratory population that do not continue on to Mexico. Additional small ephemeral populations are found during the winter along the southern Atlantic Coast and the Gulf Coast of the southern United States, but the source and breeding status of these populations are poorly understood.

Monarchs breed throughout the year in the Mexican states of Morelos, Guerrero, Mexico, Oaxaca, Veracruz, San Luis Potosí, Chiapas, Michoacán, and Hidalgo (Montesinos 2003). Montesinos (2003) reports finding eggs and larvae on *A. curassavica* in all of these locations,

and on *A. glausences* in Michoacan. The degree to which these local populations interbreed with the migratory butterflies is unknown.

World Wide Distribution[TC "World Wide Distribution" \f C \l "1"]

In the Americas, monarchs range from southern Canada south into northern and western South America. Central American, South American, and Antillean monarchs do not migrate, although those in Costa Rica move from lowland deciduous forests in the dry season to the rainforest (Haber 1993). During the 19th century, monarchs colonized islands throughout much of the Pacific and Atlantic Oceans, and now have well-established populations in Australia; parts of Micronesia, Maderia and the Canary Islands; and parts of Spain and Portugal (Vane-Wright 1993). It is likely that most of this movement is due to humans, but the mechanisms for monarch colonization of new areas are not documented. There are also anecdotal sightings of monarchs in other parts of Europe, including the United Kingdom, but these have not led to established populations.

Historical information[TC "Historical information" \f C \l "1"]

Commented [dcc5]: Moved to Description of Species section

~~*First Description*~~*[TC "First Description" \f C \l "2"]*

~~The monarch butterfly was named *Papilio plexippus* by Linnaeus in 1758 (Vane-Wright 2007). It is the type species of the genus *Danaus*, which was named by Kluk in 1780.~~

Discovery of the Overwintering Sites[TC "Discovery of the Overwintering Sites" \f C \l "2"]

The means by which monarchs survived winter was a source of speculation for well over a century, and the discovery of the overwintering sites resulted from a trinational effort. A thorough reconstruction of this speculation and the many researchers who attempted to understand the monarch's annual cycle is presented by Brower (1995). While monarchs were possibly seen migrating by one of Christopher Columbus's expeditions to eastern Mexico, the first official report of monarch migration was not until 1857 when D'Urban reported dark clouds of monarchs in the Mississippi Valley (Brower 1995). A complete understanding of the magnitude of the incredible migratory phenomenon was the result of an ingenious butterfly tagging program started by Canadians Fred and Norah Urquhart in the 1930's. The Urquharts expanded this program by enlisting volunteer "Research Associates" in 1952. This army of volunteers, including school children, naturalists and adults, tagged thousands of butterflies over four decades. Over the years, documented tracking of individual butterflies suggested that monarchs from the northeastern and north central parts of the United States and southeastern Canada overwintered somewhere in Mexico. In 1973, after reading an advertisement in a Mexican newspaper, Kenneth Brugger offered his help in finding the overwintering site. He and his wife, Catalina Aguado, searched for signs of monarchs, and, led by a local peasant, found millions of monarchs congregating in an oyamel fir forest in the mountains of eastern Michoacán on 2 January 1975 (Urquhart 1976).

Figure 10. Insert pictures of overwintering sites, Urquhart and/or Brugger here

Scientists credit Mr. Brugger for discovering the oyamel forests in Mexico where hundreds of millions of monarch butterflies spend the winter. However, local residents already knew that

millions of monarchs returned to their mountains every year, and had incorporated this phenomenon into their culture. They were locally known as *palomas* (doves) as well as *cosechadoras* (harvesters, since they arrive at the time of harvesting). Mazahuas and Otomies indigenous people also related the arrival of the butterflies to the "Day of the Dead" *(Día de muertos)*, believing that the butterflies were the souls of their ancestors. The Urquharts' tagging program and subsequent research provided local residents with the knowledge that the butterflies came from and returned to a huge and distant region, the entire eastern United States and southeastern Canada.

Current status and condition[TC "Current status and condition" \f C \l "1"]

Eastern Populations [TC " Eastern Populations " \f C \l "2"]

The eastern population is monitored in many locations using many methods. Monitoring programs assess local densities of breeding monarchs throughout their breeding range, numbers of individual butterflies passing through migratory stop-over sites, and areas occupied on the winter range. Other programs assess the timing and location of fall and spring migratory movement. The fact that monarchs are spread over such a large area for most of their annual migratory cycle make their population dynamics difficult to assess, and integrating information from so many different programs presents a scientific challenge that we are only beginning to address.

Commented [dcc6]: This paragraph belongs under this heading as it is a general discussion of eastern populations.

Winter Monitoring:[TC "Winter Monitoring:" \f C \l "3"] ~~The eastern population is monitored in many locations using many methods. Monitoring programs assess local densities of breeding monarchs throughout their breeding range, numbers of individual butterflies passing through migratory stop-over sites, and areas occupied on the winter range. Other programs assess the timing and location of fall and spring migratory movement. The fact that monarchs are spread over such a large area for most of their annual migratory cycle make their population dynamics difficult to assess, and integrating information from so many different programs presents a scientific challenge that we are only beginning to address.~~

The dense aggregations in known overwintering sites provide the only opportunity to measure the entire eastern migratory population at one time, and a variety of monitoring programs have provided data on the relative size of the population, numbers of colonies, and mortality from year to year. Since the early 1990's, CONANP personnel in the ~~Monarch Butterfly Biosphere Reserve (~~MBBR, ~~administered by CONANP)~~ and staff of the World Wildlife Fund (WWF)–Mexico~~)~~ have monitored the areas and locations occupied by monarchs throughout the wintering season, with the assistance of local residents (Garcia-Serrano et al. 2004, Rendón-Salinas et al. 2007). Beginning in 2004, these monitoring activities have included biweekly measurements ~~biweekly throughout the overwintering season (~~from November to March~~)~~ (Rendón-Salinas and Galindo-Leal 2005; Rendón-Salinas et al. 2006a, 2006b).

Different methods have been used to indicate how occupied area translates to monarch numbers, including mark-release-recapture methods and estimates of the numbers of monarchs occupying trees of different sizes (reviewed by Calvert 2004). Density estimates range from about 7 to 60 million monarchs per hectare, and Brower et al. (2004) showed that early estimates of 10 million monarchs per hectare probably grossly underestimated actual numbers. The wide range of estimates suggests that monarch densities are not consistent among colonies, years and seasons,

but the area occupied by monarchs is used as a very rough estimate of population size. Such data are available for most years from 1976 to the present, although the degree to which all colonies were found and measured varies considerably.

Figure 11. Insert pictures of monitoring teams here (WWF and MBBR)

Breeding Population Monitoring:[TC "Breeding Population Monitoring:" \f C \l "3"] Two long-term monitoring programs with broad geographic ranges have focused on the breeding stage of the monarch annual cycle, the Monarch Larva Monitoring Project (MLMP) and the North American Butterfly Associations's (NABA) Fourth of July Butterfly Count (Oberhauser 2007). The MLMP ([HYPERLINK "http://www.mlmp.org"]) is a citizen science project developed by researchers at the University of Minnesota that engages volunteer monitors in weekly surveys of immature monarchs on milkweed plants throughout the breeding range. Volunteers provide weekly estimates of monarch egg and larval densities in their monitoring sites. While this program covers the monarch breeding range fairly completely, densities are reported on a per plant basis. This method is easy for volunteers to carry out, but the translation of per plant density into overall numbers suffers some of the same problems as using area occupied to indicate the size of the overwintering population.

Volunteers participating in the ~~North American Butterfly Association's~~ (NABA) annual Fourth of July Butterfly Count monitor summer populations of many adult butterflies, including monarchs (Swengel 1995). During this annual count, volunteers select an area 24 km in diameter and conduct a one-day census of all butterflies sighted within that circle. The counts are usually held within a few weeks of July 4th in the United States, July 1st in Canada and September 16th in Mexico. Like the MLMP, the Fourth of July Counts cover a broad geographic range. However, the count at any given location is conducted on a single day each summer, and may miss monarch population peaks.

Figure 12. Insert pictures of volunteer monitors here

Migration Monitoring:[TC "Migration Monitoring:" \f C \l "3"] Several programs monitor the size, timing and location of autumn monarch migrations at specific locations. The longest running project has been conducted in Cape May New Jersey since 1992 by Dick Walton and collaborators (Walton and Brower 1996, Walton et al. 2005). From September 1 to October 31, monitors conduct from two to three driving censuses per day, recording the number of monarchs observed nectaring, flying or resting as they drive 10 km/hr. A study using similar methods has been conducted in the U.S. Fish and Wildlife Service's (USFWS) Chincoteague National Wildlife Refuge on Assateague Island, a barrier Island on the Delmarva Peninsula in Virginia, beginning in 1997 (Gibbs et al. 2006). Another program monitoring the fall migration involves volunteers in the Peninsula Point Recreation Area in Michigan's Hiawatha National Forest, administered by the United States Forest Service (USFS) (Meitner et al. 2004). This project, started in 1996, is located on the northern shore of Lake Michigan at a migratory stopping point for monarchs. Volunteers conduct three counts every day throughout the time that monarchs are leaving Michigan, from the second week of August through the third week of September. In Canada, Mmonarch migrations through Long Point National Wildlife Area and Point Pelee National Park, on the north shore of Lake Erie in Ontario, are also monitored each fall. Long Point data collected from 1995 through 2006 have been analyzed by Crewe et al. (2007).

In addition to these point count methods, the timing of the spring migration of the eastern population has been monitored on a continental scale since 1997 by volunteers who report first sightings to the Journey North, an online study of wildlife migration and seasonal change, and Monarch Watch, a research project based at the University of Kansas programs (Howard and Davis 2004). In a similar way, the temporal and spatial patterns of fall migration are monitored throughout the flyway through reports of overnight roost sites collected by the Journey South program (United States and Canada) and Correo Real program (Mexico). These studies help to identify specific locations and types of habitat that are essential during fall migration. Data from the Monarch Watch fall tagging program also identify migratory pathways, and have been used to delineate yearly geographic variation in the largest concentrations of migrating monarchs.

Eastern Population Trends:[TC "Eastern Population Trends:" \f C \l "3"] In an analysis of seven programs that have provided consistent data for over ten years, including estimates from breeding, migrating and wintering phases of the annual cycle, Oberhauser (2007 and unpublished) found that most programs reported relative abundance values below average from 2002 through 2006, although relative abundance values from 2005 and 2006 rebounded from those reported in 2002-2004. Detailed analyses of these data will help to inform additional data collection efforts to explain the reasons for observed patterns. However, the large year-to-year variation in monarch densities will make it difficult to detect long-term trends, and it is important that existing programs continue to collect monitoring data.

Analyses during the winter in Mexico provide the only opportunity to measure the entire Eastern population at one time in a relatively defined location, although these analyses rely on the problematic use of hectares occupied as a surrogate for total population size (see above). Winter data show peaks of a cumulative area occupied by monarchs of about eighteen hectares in 1990 and 1996, but occupied areas of less than ten hectares in all but one winter (2003) over the past decade. An all time low was recorded in January 2005 at 2.19 hectares (Rendón-Salinas and Galindo-Leal 2005, Cruz-Piña et al. 2006).

Figure 13. Insert representative graphs here, including ow graphs

Crewe et al. (2007) noted a (statistically insignificant) decrease of about 3% in the number of migrating monarchs that pass through the Long Point National Wildlife Area monitoring site in Ontario site over the 11 years of their study. They suggested that high variation among years contributed to the non-significant trend, and that more data are needed to determine whether the monarch butterfly population passing through Long Point will continue to decline, remain stable at its current below-average level, or continue to show periodic recoveries.

Western Populations[TC "Western Populations" \f C \l "2"]

Monarch population sizes at wintering sites in California are estimated annually within two weeks of Thanksgiving, and in many years, there are data available throughout the season. Long-term data on monarch abundance at California wintering sites exist in the California Department of Fish and Game's Natural Diversity Data Base (NDDB). The NDDB contains information on 332 separate wintering sites habitats, approximately 60% of which are privately owned, and 40% of which are publicly owned, mostly in state parks.

In-depth analyses of these counts at one extensively monitored site (Frey et al. 2004, Frey and Schaffner, 2004) reveal a five year decline ending in 2003 at an extensively monitored site, with a low of approximately 10,000 overwintering butterflies in 2002-2003. During 2004, monarch butterfly numbers were significantly higher than those in 2003, with over 70,000 monarchs. These values were 45,000 butterflies in the 2005-2006 season and 60,000 in the 2006-2007 season (Ventana Wildlife Society 2007).

Current factors causing loss or decline[TC "Current factors causing loss or decline" \f C \l "1"]

Breeding habitat loss and degradation[TC "Breeding habitat loss and degradation" \f C \l "2"]

Monarch dependence on milkweed plants for reproduction means that any factors that result in a decline in milkweed abundance can affect monarch abundance. A 2000 study of the use of agricultural habitats by monarchs suggested that as many as 70% of monarchs that migrate to Mexico may have fed on milkweed in agroecosystems (Oberhauser et al. 2001), but two factors are leading to a decline in the availability of milkweed in these habitats. First, changing farming practices and suburbanization of agricultural land result in extensive habitat loss; some estimates suggests the loss of 2400 or more hectares of open space (both agricultural land and natural areas) per day to development (an annual loss of 876,000 hectares/year) (NRCS 2001, American Farmland Trust 2007). Second, increased use of genetically modified crops, particularly herbicide tolerant soybeans, also results in a loss of habitat useful to monarchs. Most soybeans and a large portion of corn currently grown in the United States are genetically modified to allow post-emergence applications of glyphosphate glyphosate (e.g. Roundup®) (James 2001, USDA 2007), which results in fields with less milkweed and other weeds (Oberhauser in prep.). While *A. syriaca* can survive the tilling that was formerly used to control weeds in most soybean and corn fields, it is unable to endure repeated application of glyphosphateglyphosate.

Corn that is genetically modified to contain a Bt toxin (from the bacterium *Bacillus thuringiensis*) that kills lepidopteran pests, particularly the European corn borer, may also pose a risk, since toxic pollen from the corn may be blown onto milkweed plants and consumed by monarch larvae (Losey et al. 1999, Oberhauser et al. 2001). However, the use of Bt corn varieties that contain less Bt in their pollen (Sears et al. 2001), and the lack of milkweed in and near cornfields due to herbicide tolerant crops has decreased the risk from this form of genetically modified crop.

Roadsides once constituted a small, but significant, portion of monarch habitat. Due to herbicide application and mowing, these habitats have mainly changed to grasslands which contain few flowering plants, and thus provide poorer quality wildlife habitat. Additionally, milkweed is considered a noxious species in some areas, resulting in eradication efforts.

Figure 14. Insert picture of roadside milkweed here

In some areas across North America, milkweed plants are also being severely damaged by ozone pollution. Common milkweed is particularly sensitive to ozone damage, which is manifested by sharply defined, small dot-like lesions, called stipples, on the upper surfaces of the leaves (Bennett and Stalte 1985). In cases of severe ozone damage, the leaves may exhibit large dark

areas on the upper leaf surface as the markings blend together. The impact of ozone damage on monarch larvae is not known.

Other anthropogenic factors, such as elevated carbon dioxide, may also impact milkweeds. Thus, human activities may be changing the distribution and abundance of milkweeds in ways that are as yet not understood.

Most of the focus on breeding habitat is in the United States and Canada, since monarchs that migrate to the overwintering sites in Mexico and California come from these locations. However, there are small local monarch populations in Mexico. The milkweed used by these local populations is subject to herbicide applications, especially in areas where cattle graze. Additionally, the riparian habitat in which milkweed grows is threatened by deforestation or land change (Eneida Montesinos, personal communication).

Wintering habitat loss and degradation[TC "Wintering habitat loss and degradation" \f C \l "2"]

Mexico[TC "Mexico" \f C \l "3"]: Several researchers have documented loss of Mexican overwintering habitat. Brower et al. (2002) used aerial photographs from 1971, 1984 and 1999 to document increasing rates of forest degradation (in and near the area protected by the 1986 decree) over the two time intervals between the photographs (annual rates of 1.7% from 1971 to 1984, and 2.4% from 1984 to 1999). The latter rate was slightly higher in the area protected by the 1986 decree. Considering only the mountainous relief of a similar study area, Ramírez et al. (2003) found an annual disturbance rate of 1.3% ~~plus~~and 0.1% of land use change. Both analyses covered only three of the five sanctuaries protected. Ramirez et al. (2006) used satellite images from 1986 - 2006 to document an accumulated loss and disturbance of 10,500 hectares of forest land from the ~~Reserve~~MBBR (as defined by the 2000 decree) - equivalent to a fifth of the entire ~~current~~ area currently protected.

~~From~~ Since 2001, ~~onwards~~ WWF-Mexico and the Mexican Nature Conservation Fund (FMCN) have annually monitored forest loss in the core and buffer areas of the MBBR, and have reported losses of over 560 hectares in a single year (from 2005 to 2006) (Ramirez and Zubieta 2005, WWF 2004, 2006). Illegal logging activities have been responsible for most of the deforestation documented, but subsistence farming activities are also a concern (WWF 2004). Although the MBBR has official protected status, the land is divided in more than 100 private properties (70% under communal regimes). Thus forest conservation and forest disturbance are related to property boundaries rather than to official protection limits, and show a high concentration of disturbance in about a dozen properties (Ramírez et al. 2006).

Annual monitoring results are reported ~~given directly~~ to the governors of the states of Michoacán and ~~Estado de~~ Mexico, and the Mexican Minister of Environment (SEMARNAT). Under strong pressure from ~~current~~ President Felipe Calderon, the Mexican government has shut down illegal sawmills and charged people with crimes associated with illegal logging. The 2006-2007 forest cover assessment indicated a decrease in the rate of forest loss and deterioration in the core area of the ~~Reserve~~MBRR, which could be the result of the current Mexican presidential policy of "Zero Tolerance to Illegal Logging". Future assessments will provide a test of this policy.

Commented [dcc7]: What is the percentage decrease?

There is increasing evidence that diversion of water for human use could result in severe degradation of the overwintering sites. Successive years have resulted in the installation of increasing numbers of plastic pipes that divert water out of the overwintering forests for human and domestic animal use. For example, in the Ojo de Agua ravine on the south face of Cerro Pelon, water has been diverted to the extent that the stream bed is dry for more than a kilometer. Monarchs fly down that ravine for more than 2 km to obtain water further downstream (L. Brower, personal communication). Increasing distances to water will presumably result in increased ~~lipid~~ consumption of the lipids that keep the butterflies alive through the winter.

Potential biological causes of habitat degradation include the dwarf mistletoe, (*Arceuthobium abietis religiosae*) and insects, particularly bark beetles, although the long-term impacts of infestations with either of these are poorly understood. Some researchers have estimated that approximately 5,000 hectares of oyamel fir (*A. religiosa*) have different levels of mistletoe infection, and suggest that management strategies to manage these outbreaks need to be addressed (Hoth 1993).

Forest fires in the MBBR cause both habitat loss and direct impacts on monarchs if they occur during the overwintering period. Smoke disturbs the roosting butterflies, making them fly off of their roosting sites. Fires are most common in the MBBR buffer zone and near towns, where agricultural practices include burning to clear land for crops and grazing. Recent data show surface areas of 616 and 342 hectares affected by fire in 2003 and 2005, respectively, with a low of 76 hectares in 2007. There were 27 fires in 2007, 11 and 16 in the states of Mexico and Michoacan, respectively (F. Martinez, personal communication), and local community members are involved in many aspects of fire prevention and combat.

Commented [dcc8]: Burned?

Finally, high numbers of tourists and degradation of the overwintering environment due to poorly-regulated visits may be harming monarchs (Brenner and Hubert 2006, Carlos Galindo-Leal, personal communication). For the past thirty years, tourism to the overwintering sites in México has been increasing. At present, there are between 100,000 and 150,000 visitors every year, most of them concentrated in the Sierra El Campanario Sanctuary (El Rosario Ejido), during the weekends of ~~four months~~December through March. In spite of thirty years of experience, tourism continues to be poorly organized. Ejidos with tourism activity lack ~~businesses~~ plans and do not reinvest ~~part of the~~ income on maintenance or capacity building activities. At present, there is no formal assessment of the impacts of tourism, but there are several indications that tourists are having negative impacts. Local guides protect the butterflies in areas that receive high numbers of visitors with a variety of crowd control techniques, but the process of getting the tourists to the sites, often on horseback in the Sierra Chincua Sanctuary, leads to ~~path~~ trail degradation and erosion, and extremely dusty conditions that can lead to blocked spiracles (air passages) and butterfly suffocation (K. Oberhauser, personal observation). Food and handicraft shops in El Rosario and Chincua take up more and more area and produce more garbage. Increased firewood harvesting to support small restaurants ~~in El Rosario and Chincua~~ may be harming endemic junipers and other native plants. Tourists and horses are dispersing invasive plants, particularly the weed *Acaena elongate* (Family Rosaceae, known in Mexico as Pegarropa (meaning *adheres to cloth*, based on the velcro-like quality of the seeds)), and possibly disturbing the butterflies with noise and increased carbon dioxide levels. Brenner and Hubert (2006) suggest that there is a serious problem of coordination of tourism activities. Neither policies oriented to different target tourist groups nor a comprehensive visitor management plan have been developed, resulting in the same low-quality services and products

for everyone, without considering the expectations and financial means of different ecotourism segments (Brenner and Hubert 2006).

Figure 15. Insert Ramirez or other images here

California[TC "California" \f C \l "3"]: There has been extensive loss of wintering habitat in California, with a decline of over 12% in the number of wintering habitats available to monarchs from 1990 to 1998 (Meade 1999, Frey and Schaffner 2004). Factors that have resulted in the loss of appropriate habitat include tree growth that results in increased shading, and tree loss due to factors such as senescence, diseases, and commercial and municipal development (Meade 1999, Leong et al. 2004). Monarch habitat has also been destroyed in California by monarch-focused recreational activities. For example, a famous overwintering site at Pacific Grove was destroyed when a motel was built among the butterfly trees ~~for~~ to accommodate visitors to the site (Lane 1993).

Disease and Parasites[TC "Disease and Parasites" \f C \l "2"]

Monarchs are affected by a variety of infectious diseases caused by viruses, bacteria, fungi, protozoans, nematodes and mites. They are also heavily preyed upon by a number of predators and parasitoids.

Parasitoids[TC "Parasitoids" \f C \l "3"]: Parasitoids are insects that deposit eggs in or on other insects. The larvae of these species eat their hosts from the inside, and generally emerge from the carcass of a larva, pupa or adult. Parasitoids that consume monarch larvae include both flies and wasps. Tachinid fly larvae feed on monarch caterpillars, usually killing their host just before pupation. From one to several fly maggots emerge from the host, and drop to the ground on long, gelatinous tendrils. In some localized populations, most monarch larvae are parasitized by tachinid flies, but parasitism rates are generally from 5 to 20% (Oberhauser et al. 2007). Various parasitoid wasp species also parasitize monarch larvae, but less is known about their importance, probably because wasps tend to parasitize pre-pupal larvae, and are thus less likely to be found by researchers. Braconid wasp parasitism may result in as many 32 adult wasps from a single monarch carcass.

Parasites[TC "Parasites" \f C \l "3"]: Monarchs are infected by a nuclear polyhedrosis virus and *Pseudomonas* bacteria. A protozoan parasite, *Ophryocystis elektroscirrha*, is found in both wild and captive populations, and a microsporidian *Nosema* species has been identified in captive monarchs (University of Georgia 2007); both of these infections can have debilitating effects on monarchs. Horsehair worms, in the phylum Nematomorpha, have been observed in monarch larvae (Prysby and Oberhauser unpublished). *O. elektroscirrha* is the ~~best~~ only well studied monarch parasite. The inactive spore of this protozoan disease is mixed among the scales on the integument of monarch adults, and spread from mother to offspring when larvae ingest spores deposited onto the eggs or surrounding milkweed. This parasite can reduce larval survival, butterfly mass, and life span (Altizer and Oberhauser 1999). Populations that do not migrate, such as those in southern Florida and Hawaii, have the highest parasite infections, with about 70% heavily infected individuals. Only about 30% in western North America and 8% in the eastern migratory population are heavily infected (Altizer et al. 2001).

Figure 16. Insert pictures of predators and/or parasites here

Climate Change[TC "Climate Change" \f C \l "2"]

Monarchs overwinter in specific climatic regions in the montane oyamel fir forests located in Mexico. Oberhauser and Peterson (2003) used ecological niche models to identify a narrow range of temperature and precipitation that allowed monarchs to survive the winter. Conditions predicted by climate change models suggest that the current overwintering sites will not be suitable for monarchs in 2055. Hadley Climate Center models predict increased precipitation during the winter in the Mexican wintering sites, but little change in temperature. Using conditions predicted for 2055, Oberhauser and Peterson (2003) predicted increased ~~coincidence of~~ precipitation ~~and~~during cold weather, such as the conditions that killed up to 70-80% of the two largest overwintering populations in 2002 (Brower et al. 2004). While 50% of monarchs can survive temperatures of -8˚C by supercooling if they are dry, 50% of wet individuals are frozen at temperatures of -4.4˚C (Anderson and Brower 1993, 1996).

Batalden et al. (2007) also used ecological niche modeling to study the summer breeding range of monarchs and how it may be impacted by climate change. Monarchs follow warm, moist conditions as they move northward in the spring, but are able to utilize a wide area without directional flight throughout most of the summer. Climate change model predictions suggest that monarchs' ecological niche, at least as defined by temperature and precipitation, will move northward, necessitating movement by all summer generations. The degree to which monarchs will be able to utilize newly-available conditions to the north depends on whether they can change their migratory patterns, and the ability of milkweed to colonize areas in which it does not currently grow.

Figure 17. Insert graphics showing habitat location changes here

Pesticide Use[TC "Pesticide Use" \f C \l "2"]

The use of herbicides was discussed above. In addition to the loss of habitat caused by herbicides that remove monarch host plants and nectar sources, monarchs can be killed outright by insecticides used to control pest insects. Insecticides may be important sources of mortality in agricultural areas, in urban and suburban areas where adult mosquito control programs are utilized (Oberhauser et al. 2006), and near forests that are being sprayed with Bt to control forest pests, particularly gypsy moths. While all of these insect control methods have the potential to kill monarchs, the degree to which they affect overall population numbers is unknown.

Legal Status, Management and Action[TC "Legal Status, Management and Action" \f C \l "1"]

Concerns about the long-term viability of monarchs in North America have resulted in several legal protection efforts. Much of this concern is centered on monarch habitat needs, and the rate of loss of habitat used by monarchs. The difficulty in accurately measuring monarch populations, their complicated migratory life cycle, and year to year variation in monarch density make it difficult to link monarch numbers to large-scale habitat availability. Thus, there is still speculation about the short-term impacts of habitat loss on monarchs. However, we do know that monarch habitat is being lost during each of its three life history stages (breeding, migrating

and overwintering). The extraordinarily dense concentrations in the Mexican overwintering sites make threats there of particular concern.

International[TC "International" \f C \l "2"]

As a result of perceived threats to the monarch, the winter roosts in Mexico and California were designated as threatened phenomena by the International Union for the Conservation of Nature and Natural Resources (IUCN) in the IUCN Invertebrate Red Data Book in 1983 (Wells et al. 1983, Malcolm 1993). This was the first designation for a biological phenomenon, as opposed to a species, in the history of international conservation. It recognizes the fact that the migratory phenomenon, which involves millions of monarchs migrating to distant overwintering sites each year, is imperiled, even though the species as a whole is not in danger of extinction. ~~No specific protection is conferred by this designation.~~ Mexico's Monarch Butterfly Biosphere Reserve was inscribed on the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Network of Biosphere Reserves in 2006. The Advisory Committee for Biosphere Reserves recommended that Mexican authorities increase cooperation with Canadian and United States authorities responsible for key sites along monarch migratory routes. No specific international protection is conferred by either the IUCN or UNESCO designation.

A number of ~~Several~~ continent-wide monarch conservation initiatives ~~activities~~ have been endorsed by cooperative activities of the governments or government agencies of Mexico, Canada and the United States, ~~that directly or indirectly benefit monarchs.~~ The CEC, in partnership with the Trilateral Committee for Wildlife and Ecosystem Conservation and Management and other agencies, has supported several efforts to protect monarchs. In 1997, the CEC and US Fish and Wildlife Service (USFWS) convened a stakeholders' meeting in Morelia, Michoacán to develop a long-term strategy for monarch conservation (Hoth et al. 1999), and a USFWS-supported meeting in Lawrence Kansas in 2001 resulted in a summary of important research and conservation objectives (Oberhauser and Solensky 2001).

Since 1995, the USFWS Wildlife Without Borders - Mexico grants program, has partnered with Mexican authorities and non-governmental organizations to protect and restore the wintering habitat of the monarch butterfly. Between 1995 and 2006, USFWS awarded almost $800,000 in grants for monarch projects. About 94 percent of the funds were for projects to develop the capacity of the local communities of the MBBR to sustainably manage their natural resources. The Service partners with Mexican authorities and ALTERNARE, A.C. to support a training program to develop the natural resource management capabilities of local communities and has funded programs to provide training in reforestation techniques for peasant farmers living in the MBRR.

Since 1993, the USFS-International Programs has been working with MBBR managers and partners in the region to build management capacity, provide guidance to communities for resource management, and conserve natural resources in the core zone of the MBRR. Staff from the Willamette National Forest and other units has provided training and consultations on forest inventory, GPS/GIS utilization, and design and maintenance of trails. Through a partnership with the Monarch Model Forest, partners developed proposals to assist with recreation management and ecotourism, landscape ecology, small-scale wood product development and marketing, and community incentive programs.

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~~The initiative to develop this North American Monarch Conservation Plan was launched at a December 2006 Monarch Flyway Conservation Workshop sponsored by the USFS, U.S. Agency for International Development (USAID), Texas Parks and Wildlife Department (TPWD), the Wildlife Trust, and the City of McAllen Texas. In June 2007, the CEC Council signed a resolution on trinational cooperation to conserve monarchs and directed the CEC Secretariat to support multi-stakeholder, collaborative efforts to develop a monarch conservation plan with the aim of maintaining healthy monarch populations and habitats throughout the migration flyway.~~

In ~~2005~~March 2006, the Trilateral Committee for Wildlife and Ecosystem Conservation and Management (Trilateral Committee) initiated a project to establish a network of Sister Protected Areas to collaborate on monarch conservation projects focused on habitat preservation and restoration, research, monitoring; environmental education and public outreach. Thirteen protected areas administered by the USFWS, US National Park Service (USNPS), Canadian Wildlife Service (CWS), Parks Canada Agency (PCA), and Mexico's National Commission of Natural Protected Areas (CONANP) were identified as part of the initial network (Table 1).

Table 1. Sister Protected Area Network Sites

Mexico
Mariposa Monarca Biosphere Reserve (Michoacan) (CONANP)
Parque Nacional Iztaccihuatl Popocatepetl Zoquiapan (Edo. de Mexico, Puebla, Morelos) (CONANP)
Parque Nacional Cumbres de Monterrey (Nuevo Leon) (CONANP)
Area de Proteccion de Flora y Fauna Maderas del Carmen (Coahuila) (CONANP)
United States
[HYPERLINK "http://www.fws.gov/southwest/refuges/texas/balcones/"] National Wildlife Refuge (Texas) (USFWS)
[HYPERLINK "http://www.fws.gov/saintmarks/"] National Wildlife Refuge (Florida) (USFWS)
[HYPERLINK "http://flinthills.fws.gov/"], [HYPERLINK "http://www.fws.gov/quivira/"], and [HYPERLINK "http://maraisdescygnes.fws.gov/"] National Wildlife Refuges (Kansas) (USFWS)
[HYPERLINK "http://www.fws.gov/midwest/nealsmith/"] National Wildlife Refuge (Iowa) (USFWS)
[HYPERLINK "http://www.nps.gov/cuva/management/rmprojects/butterflies.htm"] Valley National Park (Ohio) (USNPS)
Canada
Long Point National Wildlife Area (Ontario) (CWS)
Point Pelee National Park (Ontario) (PCA)

Figure 18. **Map of the above areas.**

~~The initiative to develop this North American Monarch Conservation Plan (NAMCP) was launched at a December 2006 Monarch Flyway Conservation Workshop sponsored by the USFS, International Programs, U.S. Agency for International Development (USAID), Texas Parks and Wildlife Department (TPWD), the Wildlife Trust, and the City of McAllen Texas. The NAMCP~~

initiative was endorsed by the Trilateral Committee in May 2007 and in June 2007, the CEC Council, through Resolution 07-09 directed the Secretariat to support the NAMCP development effort. The CEC, Trilateral Committee, and USFS-International Programs are also supporting efforts to develop a trilingual Monarch Butterfly Monitoring Handbook of standardized monitoring protocols linked to existing monitoring programs for use by land managers, citizen scientists, NGOs, and educators across North America.

The North American Pollinator Protection Campaign (NAPPC) is an alliance of pollinator researchers, conservation and environmental groups, private industry, and state and federal agencies in all three countries (www.napeenappc.org). NAPPC works to organize local, national, and international projects involving pollinator research, education and awareness, conservation and restoration, special partnership initiatives, and policies and practices. The main goal of the campaign is to show a positive impact on population health of pollinating animals, such as monarchs, within five years. There is a specific NAPPC task force focused on monarch monitoring and conservation.

Canada[TC "Canada" \f C \l "2"]

The Species at Risk Act (SARA), passed by the Canadian government in 2003, established a legislated process for the assessment, listing and recovery of species at risk (Environment Canada 2007). In addition to its legal list of species at risk, SARA includes general prohibitions and provisions for enforcement. The Act provides protection for all listed endangered, threatened and extirpated species and protects the critical habitat of these species where they occur on federal lands. Under SARA, the Canadian government develops management plans that set conservation goals and objectives, identify threats to species, and indicate the main areas of activities to be undertaken to address those threats. The monarch is listed as a species of Special Concern under SARA because of a combination of biological characteristics and identified threats, especially risks to the overwintering sites in Mexico.

The *Canada National Parks Act* also protects the monarch at Point Pelee National Park in Ontario. In 1995, Canada and Mexico signed a declaration to create an International Network of Monarch Butterfly Reserves. The two nations pledged to jointly expand this network. Three areas in Southern Ontario were designated as Monarch Butterfly Reserves under the declaration: Point Pelee National Park, Long Point National Wildlife Area and Prince Edward Point National Wildlife Area. All three of these areas were protected before the declaration.

In 1997, the Legislature of the Province of Ontario passed the Fish and Wildlife Conservation Act. This Act gave "Special Status" to a number of invertebrate species, including the monarch butterfly. The Act requires that anyone in Ontario rearing, capturing, tagging, or conducting research on monarchs apply for special permits to conduct such activities.

United States[TC "United States" \f C \l "2"]

There is currently no special legal status at the federal level for monarch butterflies or their habitat in the United States.

In California, current legal protections involve a patchwork of city ordinances, coastal zone management plans and state law. In 1987, the California legislature passed Assembly Bill #1671

to recognize the monarch's migration and winter aggregation as a natural resource and to encourage the protection of its winter habitat. A year later, California voters approved a bond issue allocating $2,000,000 to purchase critical overwintering habitat (Snow and Allen 1993). As a result, some winter roosts in state, county or town parks receive protection. A small number of Californian cities and counties have enacted ordinances that prohibit activities that disturb monarchs and their winter roost trees. Of the ordinances currently in place, many apply these prohibitions only when monarchs are present.

~~Several activities of government and~~ A number of universities, non-government agencies and organizations in the United States directly and indirectly support monarch conservation. For example, the Monarch Watch program (University of Kansas) supports the creation of Monarch Waystations to provide monarch nectaring and breeding habitat along the migratory path of monarchs. In the fall of 2007, over 1800 waystations ranging in size from 100 to over 1000 m^2 had been registered. Other organizations, such as Journey North, the Monarch Butterfly Sanctuary Foundation, the Michoacán Reforestation Fund, the Monarch Program and Monarchs in the Classroom (University of Minnesota) raise funds to support monarchs directly, and increase awareness of monarchs through a variety of educational programs. The Xerces Society for Invertebrate Conservation, working with the Ventana Wilderness Society, and California Polytechnic State University are managing an effort to census overwintering monarch populations in Thanksgiving counts. The Xerces Society is also gathering and assessing the legislation and/or ordinances of the State of California, and municipalities as they relate to ~~m~~Monarch overwintering sites (see also Brower et al. 1993).

The TPWD, through the Texas Monarch Watch program, supports monarch monitoring workshops and provides information packets for volunteers involved in monitoring. TPWD also contracts with scientists to monitor transects on highway rights-of-way. In addition, units of the Texas system of protected areas hope to adopt the handbook of standardized monitoring protocols being developed in collaboration with CEC for use~~d~~ by the Sister Protected Area Network to provide greater geographic coverage along the monarch flyway. This could serve as a model for other state ~~departments of natural~~ resource~~s~~ agencies along the flyway.

Mexico[TC "Mexico" \f C \l "2"]

Three protection decrees have been enacted to protect monarch habitat in Mexico. The first (1980 decree) protected the monarch overwintering areas without specifying the locations to be conserved and ~~restricting~~ restricted extractive activities in the forests only during the overwintering season (November to March). The second (1986 decree) defined 16,110 hectares in five ~~isolated~~ discrete areas for protection along the border of the states of Mexico and Michoacán: Cerro Altamirano, Sierra Chincua, Sierra El Campanario, Cerros Chivatí-Huacal, and Cerro Pelón. Together these five areas were called the Special Monarch Butterfly Biosphere Reserve. Each area had a core and buffer zones, with a total of 4,491 ha in core zones and 11,619 ha in buffer zones. On 10 November 2000, President Ernesto Zedillo signed a third decree (2000 decree), increasing the size of the MBRR~~Reserve~~ to 56,259 ha (13,552 ha of core area and 42,707 ha of buffer). The new reserve included the creation of the Monarch Butterfly Conservation Fund (administered by FMCN), which provides economic incentives for to prevent logging by local communities who own the core area and whose forest harvesting permits were withdrawn (Missrie 2004, Galindo-Leal and Rendón Salinas 2005, Missrie and Nelson 2007).

Figure 19. Insert map showing boundaries of MBBR here

The monarch butterfly is also listed Under Special Protection in the Species at Risk Norm (NOM-054-ECOL-2001) by the Mexican Government. This means that it is considered a species or population that could be threatened by factors that negatively affects its viability, and that its ~~recuperation~~ recovery and conservation should be promoted wherever it is found.

Smaller colonies outside of the ~~Reserve~~ MBRR have varying degrees of protected status. The Iztaccihuatl-Popocatepetl National Park and Los Azufres Forest Protected Zone and Wildlife Refuge~~s~~ both regularly host small overwintering monarch populations, and these areas are protected. The Mil Cumbres colony in the Cerro Garnica area is partially included in the Cerro Garnica National Park, but in recent years the colony has established about one kilometer from the northern boundary of the national p~~P~~ark, and is thus not under any protection category. Another colony forms in Piedra Herrada near Valle de Bravo. This land was protected in a 1941 decree by President Avila Camacho as a Natural Resource Protection Zone, and a 2001 revision of the decree resulted in protection of 145,000 hectares in the watersheds of the municipalities of Valle de Bravo, Malacatepec, Xilostoc and Temascaltepec. The state of Mexico declared the Water Sanctuary Corral del Piedra (3622 ha), which also includes the monarch sanctuary of Piedra Herrada. Butterfly colonies in Cerro del Amparo and Palomas (both in the Temascaltepec Municipality, State of Mexico) are included in the Nevado de Toluca National Park. Protective actions specifically directed at monarchs have not been mandated in any of these areas, however.

Several Mexican non-government organizations (NGOs) support monarch conservation. For example, WWF-Mexico has been involved in monarch butterfly conservation, conducting activities that include colony monitoring, forest management, community restoration, eco-tourism, and environmental education programs. La Cruz Habitat Protection Project supports the planting of pine and oyamel fir trees in the area of monarch overwintering habitat. Alternare supports local communities in and near the MBRR by promoting a variety of sustainable practices, including farming, building construction and reforestation. Similar activities are conducted in the state of Mexico by Fundación Nacional para la Conservación del Hábitat Boscoso de la Mariposa Monarca (FUNACOMM), which participated in the annual Texas Parks and Wildlife ~~TPWD~~ Expo event in 2007 to seek markets for the communities' crafts. Biocenosis' Monarca program focuses on promoting conservation of threatened species and habitats, general ecosystem conservation and management, and social monitoring. Hombre y Alas de Conservación (HALCON) and Gestión Ambiental y Proyectos para el Desarrollo Sustentable Monarca (GAPDES), NGOs based in Zitacuaro, support local communities in the MBBR through projects that include land use plans, forest management programs, sustainable development and environmental restoration.

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In 2001, a Multidisciplinary Technical Scientific Workshop was organized by PROFEPA, Mexico's Attorney General for Environmental Protection, to develop a coordinated plan to systematize and integrate existing technical information and conservation efforts to clarify the causes of monarch mortality in overwintering sites. The group includes personnel from the MBBR, WWF-Mexico, and the National Autonomous University of Mexico (Universidad Nacional Autonoma de Mexico, (UNAM)) to identify risks to monarchs caused by both human activities or natural phenomena, and preventive measures to address these risks. The Forestry Commissions in the states of Michoacán and Mexico also support conservation programs and

actions, with technical assistance and subsidies in coordination with several other government organizations.

In 2004 the First Monarch Butterfly Regional Forum (Foro Regional Mariposa Monarca 2008) was organized by SEMARNAT (Mexico's Secretariat for the Environment and Natural Resources), the state governments of Mexico and Michoacán, the MBBR, and WWF-Mexico with support from the telecommunications company, Telcel. This annual event fosters coordination and collaboration among many stakeholders, identifies conservation and research priorities, promotes institutional transparency, and builds awareness about current challenges and opportunities for problem solving. The Governors of the States of Mexico and Michoacán and SEMARNAT officials have participated in every Forum.

Recently, the WWF-Telcel Alliance began working with El Rosario Ejido to develop land use and tourism business plans, and improve basic infrastructure to support more sustainable tourism. They are working to improve bathrooms for tourists to avoid discharges of sewage water in the upper watershed; have set up 65 educational, informational and crowd management signs; and worked to improve the commercial infrastructure (restaurant and shop corridor). CONANP also implemented a national strategy for sustainable tourism in Natural Protected Areas in 2007. In the MBBR, the strategy focuses on controlling and reducing harmful impacts of tourism through planning, monitoring and regulatory activities; promoting sustainable development of tourism activities by supporting infrastructure, such as more appropriate foot paths; and improving the knowledge base of individuals involved with tourism. Additionally, CONANP is working to promote year-round tourist activities that focus on the ecology of the Reserve MBBR.

Public and Commercial Perceptions and Attitudes[TC "Public and Commercial Perception and Attitudes" \f C \l "1"]

In the United States, the monarch has been designated as the state insect of Alabama, Idaho, Illinois, and Texas, and the state butterfly of Minnesota, Vermont, and West Virginia. The California Legislature Declared February 5th as California Western Monarch Day in an effort to educate the public about the importance of these spectacular butterflies. The monarch was chosen as the insect emblem of Québec in 1998 by a popular vote. It was nominated in 1989 as the national insect of the US. In Mexico, it is the representative insect of the state of Michoacán, and a popular representation of Mexican nature.

Children study monarchs in school, citizen scientist volunteers throughout North American track their migration and breeding, conservationists are concerned about impacts of human activities on monarchs, and citizens, government agencies and conservation organizations try to alleviate these impacts. Scientists study monarch mating behavior, interactions with milkweed and predators, responses to environmental change, and migration.

Part of the fascination with monarchs results from its spectacular migration, during which a single individual can traverse Canada, the US and Mexico. The concept that an organism with a mass about equal to that of a paperclip can fly thousands of kilometers from summer breeding grounds to overwintering sites in Mexico is mind-boggling, as are the aggregations of millions of butterflies, perhaps surpassed in number only by krill in the Antarctic Ocean. In addition,

because monarchs are so easy to raise and observe in captivity, many adults remember discovering a monarch larva as a child, and watching it transform into a butterfly.

Figure 20. Insert picture of person holding a monarch here

The popularity of monarch butterflies makes them the focus of conservation concern; while human activities affect all organisms with which we share the earth, monarchs engender more than their share of public concern. The attraction to monarchs, and the resultant conservation and scientific interest have enriched human knowledge of the natural world, and our resolve to preserve it.

Trinational Conservation: Goals, Objectives and Target Actions[TC "Trinational Conservation: Goals, Objectives and Target Actions" \f C \l "1"]

~~In recognition of the interdependence of the linked ecosystems of the United States, Mexico and Canada, and the emblematic importance of the monarch butterfly, the CEC Council of Ministers issued council resolution 07-09 to protect its continent-wide migration. This resolution directed the CEC Secretariat to support the existing multi-stakeholder, collaborative effort to develop a North American Monarch Conservation Plan (NAMCP), with the aim of maintaining healthy monarch populations and habitats throughout the migration flyway. A trilateral group of government, NGO, and academic representatives was charged to develop the NAMCP, utilizing activities that support information exchange, cooperative economic activities that promote environmental sustainability, and capacity building. The plan recommends activities that promote monarch butterfly conservation for the Council's consideration.~~

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Monarch conservation will require trilateral action on the parts of individuals, organizations and institutions. Here, we present objectives and actions that are designed to address the following overarching goal: *to conserve the habitat required by monarchs during their annual cycle of breeding, migrating and overwintering.* These objectives and actions represent our best understanding of aspects of monarch biology that are relevant to conservation and summarized in this document. Habitat conservation should include both protection of existing habitat, and restoration of habitat that has been degraded by human activities. Because monarchs co-exist with human populations, conservation activities must also address the social, economic and educational needs of humans living in and near monarch habitat. Additionally, because monarchs utilize a broad range of habitats that cover large geographic areas during their migratory cycle, it is imperative that conservation actions are based on a flyway approach, rather than directed exclusively towards a specific stage of the annual cycle. However, the small size and immediate human threats to the overwintering sites in Mexico and California make conservation in these areas of immediate critical concern.

To address the overarching goal of monarch habitat conservation, proposed action items address four main areas: I) Threats prevention, control and mitigation; II) Innovative enabling approaches; III) Research, monitoring, evaluation and reporting; and IV) Education, outreach and capacity building. Within each area, specific conservation objectives and actions are proposed. The broad range of monarch populations and their complicated biology, summarized in this document, require continued research on the impacts of specific actions on monarch conservation. Thus, many of the conservation objectives address ways in which we can increase our understanding of monarch biology, specifically monitoring interactions with their living and

non-living environment. Additionally, the objectives address monitoring how conservation actions affect the social and economic well-being of humans, as well as how these actions affect monarch populations.

Specific objectives of the Monarch Conservation Plan[TC "Specific objectives of the Monarch Conservation Plan" \f C \l "2"]

I. THREATS PREVENTION, CONTROL AND MITIGATION

A. Overwintering

- Decrease or eliminate deforestation due to logging and habitat conversion
- Benefit from tourism without harming monarch populations or habitat
- Determine causes of decreasing water availability and mitigate impacts on monarchs
- Determine impacts of plant and insect parasites on forests in monarch overwintering areas

B. Flyway

- Address the threats of habitat loss and degradation in the flyway

C. Breeding Areas

- Address the threats of the loss, fragmentation, and modification of breeding habitat
- Limit impact of habitat management practices on monarchs, flowering plants and milkweed

D. Across Annual Range

- Investigate the effects of global change on monarchs' survival
- Assess the impact of parasites and pathogens on monarchs and their host plants

II. INNOVATIVE ENABLING APPROACHES

- Promote environmentally sustainable income sources for individuals and institutions whose current livelihood results in degraded monarch habitat
- Support trilateral activities that promote environmental cooperation and support

III. RESEARCH, MONITORING, EVALUATION AND REPORTING

- Monitor monarch baseline performance and habitat quality, and utilize monitoring data to understand monarch population drivers
- Determine socioeconomic factors that influence the distribution and abundance of monarch butterflies
- Evaluate and assess the effects of conservation actions on monarch distribution and abundance

IV. EDUCATION, OUTREACH, AND CAPACITY BUILDING

- Expand communication and information sharing that supports monarch conservation
- Enhance capacity building, training and networking programs

Table of Specific Actions[TC "Table of Specific Actions" \f C \l "2"]

	Priority	Time Frame

I. THREATS PREVENTION, CONTROL AND MITIGATION

A. Overwintering

1. Threats due to deforestion from large-scale, organized illegal logging; small-scale, illegal subsistence logging; legal logging; and habitat conversion

Objective: Decrease or eliminate deforestation due to logging and habitat conversion

1. Assess the effects of land use changes in and near the MBBR.	Critical	Continuous
2. In Mexico, provide long term capacity building projects to support increased surveillance and enforcement programs by government, NGO and community groups.	Critical	Continuous
3. In the USA, purchase and legally protect overwintering sites in California.	Critical	Continuous
4. In Mexico, provide trilateral technical assistance and support through specific prevention and mitigation actions, such as transportation system redesign, logging road closures, etc.	Critical	3 Yrs
5. Develop and reinforce sustainable practices in communities and expand the number of communities involved in these projects.	Critical	Continuous
6. Review effectiveness of economic incentives to not cut the forest in the MBBR.	Critical	1 Yr
7. Identify and promote market trade of non-timber products that can be produced within the MBBR buffer zone and surrounding areas.	High	3 Yrs
8. Promote commercial forest plantings in the buffer zone and surrounding area.	Medium	Continuous
9. Monitor monarchs' use of core vs. buffer areas to determine if current protection is adequate.	High	3 Yrs
10. Promote and strengthen ecological restoration programs in conservation zones, and productive ~~reconversion~~ reforestation in managed zones.	High	Continuous

2. Threats due to poorly-regulated tourism

Objective: Benefit from tourism without harming monarch populations or habitat

1. Assess tourist impacts on forest habitat and disturbance to overwintering colonies.	High	5 Yrs
2. Develop a plan for sustainable ecotourism.	High	5 Yrs

3. Threats due to decreasing water availability

Objective: Determine causes of decreasing water availability and mitigate impacts on monarchs

1. Identify causes of decreasing water access and monitor water availability for overwintering monarchs.	Critical	1 Yr
2. Restore water access.	Critical	Continuous

4. Threats due to biological factors

Objective: Determine the impacts of plant and insect parasites on forests in monarch overwintering areas

1. Identify impacts of dwarf mistletoe on *A. religiosa*.	Medium	1 Yr
2. Identify impacts of bark beetles and other insects on *A. religiosa*	Medium	Continuous

B. Flyway

1. Threat: Habitat loss and degradation in monarch flyway

Objective: Address the threats of habitat loss and degradation in the flyway

1. Identify habitat types and locations that are essential for the migration (roosting sites and nectaring habitats).	High	3 Yrs
2. Assess effects of land use changes on monarch migration.	High	Continuous
3. Develop and disseminate guidelines to conserve, enhance and restore migration habitat.	Medium	M

C. Breeding Areas

1. Threat: Habitat loss and degradation in monarch breeding areas

Objective: Address the threats of the loss, fragmentation, and modification of breeding habitat

1. Determine if, when and where milkweed is a limiting resource and develop plans to plant regionally appropriate species.	Critical	3 Yrs
2. Strengthen monarch butterfly habitat protection on public and private land.	Critical	Continuous
3. Assess effects of land use changes on monarchs and milkweed (e.g. conversion of land to corn and wheat for ethanol, homes).	Critical	3 Yrs
4. Develop guidelines for farm buffers for nectar sources.	Medium	3 Yrs
5. Develop road, powerline and railroad right of way habitat protection programs; promote protection in facilities such as golf courses or parks.	Medium	Continuous

2. Threat: Habitat management practice

Objective: Limit impact of habitat management practices on monarchs, flowering plants and milkweed

1. Study and limit impact of biocides (herbicides, insecticides) on monarch populations and their habitat.	High	3 Yrs
2. Develop highway and other roadside mowing regimens compatible with monarch breeding.	High	3 Yrs
3. Develop recommendations to encourage consideration of milkweed as a beneficial plant, not a noxious weed.	Low	1 Yr
4. Control dog-strangling vine and other invasive plants that directly impact monarchs or milkweed.	Medium	Continuous

D. Across Annual Cycle

1. Threat: Global Change

Objective: Investigate the effects of global change on monarchs' survival

1. Identify direct and indirect impacts of global change affecting monarch populations (warming and other changes in weather patterns, pollution, increased UV exposure, increased CO_2, invasive species).	Critical	Continuous

B. Threat: Parasites and pathogens that affect monarchs.

Objective: Assess the impact of parasites and pathogens on monarchs and their host plants

1. Determine the role of commercial production and distribution of monarchs on disease prevalence. Consider a breeder inspection program.	Medium	3 Yrs

II. INNOVATIVE ENABLING APPROACHES

Objective: Promote environmentally sustainable income sources for individuals and institutions whose current livelihood results in degraded monarch habitat

1. Establish specific standards with local criteria for timber and non-timber products, including agricultural monarch-friendly products, throughout flyway.	Medium	Continuous
2. Develop environmentally-friendly fair trade programs for products and services (e.g. handcrafts, ecotourism).	Low	Continuous
3. Payments for environmental services (carbon sequestration, hydrological services and landscape conservation).	Critical	Continuous
Objective: Support trilateral activities that promote environmental cooperation and support.		
1. Explore legal, social, and environmental feasibility of promoting trinational agreements for conservation easements.	Medium	3 Yrs
2. Expand the Sister Protected Areas network (possibly to Amistad National Recreation Area in Texas, Maderas del Carmen in Coahuila, Parque Ecologico Chipinque in Monterrey, Sierra Gorda in Queretaro, Los Azufres Forest Protected Area in Michoacan, state parks in Texas).	High	Continuous
3. Support a bi- or trilingual staff person who will coordinate and monitor monarch conservation activities, possibly to be housed at TPWD in Austin Texas.	High	Continuous
III. RESEARCH, MONITORING, EVALUATION AND REPORTING		
Objective: Monitor monarch baseline performance and habitat quality, and utilize monitoring data to understand monarch population drivers		
1. Develop shared monitoring toolkit with protocols linked to existing programs that address breeding, migrating, and overwintering.	Critical	1 Yr
2. Distribute monitoring toolkit, and coordinate data collection.	Critical	3 Yrs
3. Create a trinational agreement to exchange data among researchers and stakeholders, perhaps by instituting a tri-country data bank.	High	3 Yrs
4. Develop a diagnosis of population drivers.	High	3 Yrs
5. Develop easily implementable, physiological assays of monarch performance such as haemolymph, lipid and water content assays of stress indicators.	Low	3 Yrs
6. Determine the influence of topography, seasonal wind patterns and other landscape features on monarch movement.	Medium	3 Yrs
Objective: Determine socioeconomic factors that influence the distribution and abundance of monarch butterflies		
1. Identify socioeconomic factors that can be targeted for monarch mitigation actions	Critical (Mexico), Medium (US and Canada)	3 Yrs
2. Identify costs and benefits, and feasibility (stakeholder acceptance) of mitigation actions for monarch conservation.	Critical (Mexico), Medium (US and Canada)	3 Yrs
Objective: Evaluate and assess the effects of conservation actions on monarch distribution and abundance.		
1. Maintain a record of conservation actions	High	Continuous

2.	Collate and analyze existing data and use them to determine whether mitigation actions have been successful.	Critical	Continuous
3.	Develop adaptive management procedures to encourage factors that result in positive changes and discourage those that result in negative changes	Critical	Continuous
4.	Develop standardized indicators to evaluate the effectiveness of economic incentives to conserve monarch habitats	Low	Continuous

IV. EDUCATION, OUTREACH, AND CAPACITY BUILDING

Objective: Expand communication and information sharing that supports monarch conservation

1.	Develop Trilateral Plan for Monarch Butterfly Flyway outreach, taking into account available and needed materials	Medium	1 yr
2.	Develop, distribute and assess educational toolkit (including sensitivity to habitat values and management) to teachers, trainers, consumers	Medium	1 Yr
3.	Use electronic and print media for increasing awareness, distributed via an easy-to-use and interactive website	High	Continuous
4.	Relate monarch migratory phenomena to climate change awareness	Low	3 Yrs
5.	Create and distribute a factsheet and other communication materials on the Monarch Butterfly Flyway status and needs to decision makers and communities	High	1 Yr
6.	Develop and distibute consumer educational material (pollination services and monarch friendly products)	Medium	3 Yrs

Objective: Enhance capacity building, training and networking programs

1.	Develop field training program for all levels of decision makers	Medium	3 Yrs
2.	Develop and conduct training programs for guides at overwintering sites and migratory staging areas	Medium	1 Yr
3.	Develop and conduct training programs for natural resource professionals on using monitoring toolkit	Medium	1 Yr
4.	Promote a trinational declaration to establish NAMCP actions as priorities for funding	Medium	1 Yr

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Appendix 1. List of Acronyms[TC "Appendix 1. List of Acronyms" \f C \l "1"]

CEC = Commission on Environmental Cooperation
CONANP = Comisión Nacional de Áreas Naturales Protegidas (part of SEMARNAT)
CWS = Canadian Wildlife Service, Service canadien de la faune (SCF)
FMCN = Fondo Mexicano para la Conservación de la Naturaleza
MBBR = Monarch Butterfly Biosphere Reserve
NAPPC = North American Pollinator Protection Campaign
NGO = Non-governmental organization (general term for many non-for-profit organizations)
OP = Ontario Parks, Parcs Ontario (PO)
PCA = Parks Canada Agency, Agence Parcs Canada (PC)
PROFEPA = Procuraduría Federal de Protección al Ambiente (part of SEMARNAT)
SARA = Species at Risk Act (Canada)
SEMARNAT = Secretaria de Medio Ambiente y Recursos Naturales
TPWD = Texas Parks and Wildlife Department
UNAM = Universidad Nacional Autónoma de México
USAID = United States Agency for International Development
USFS = United States Forest Service
USFWS = United States Fish and Wildlife Service
USNPS = United States National Park Service
WWF = World Wildlife Fund